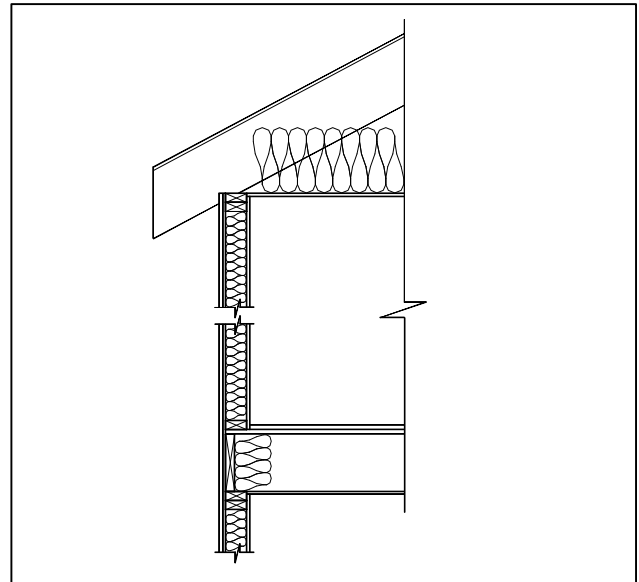


ENERGY TRADE-OFF WORKSHEET

A GUIDE FOR COMPLETING ENERGY ENVELOPE TRADE-OFF CALCULATIONS

This pamphlet provides guidelines for homeowners and designers required to complete energy trade-off calculations. Minimum requirements, the trade-off worksheet, and approved plans are subject to verification and inspection.



WHAT REGULATIONS GOVERN THE ENERGY REQUIREMENTS FOR A RESIDENTIAL SPACE

THE CODE OF VIRGINIA

The *Code of Virginia* requires that your new home, addition, or alteration comply with the Virginia Uniform Statewide Building Code (VUSBC). By reviewing plans, issuing permits, and performing field inspections, the Office of Building Code Services (OBCS) and the Department of Public Works and Environmental Services (DPWES) help you comply with the provisions of the law.

VIRGINIA UNIFORM STATEWIDE BUILDING CODE

Fairfax County is required to enforce the VUSBC, which incorporates by reference the Council of American Building Officials (CABO) One and Two Family Dwelling Code, the CABO Model Energy Code, the Building Officials and Code Administrators (BOCA) National Building Code, and the International Mechanical Code. These Codes may be purchased from Maps and Publications, located in the Government Center, 12000 Government Center Parkway, Suite 156, Fairfax, Virginia, 22035, telephone **703-324-2974**.

WHAT IS THE PURPOSE OF ENERGY TRADE-OFF CALCULATIONS

Provisions of the CABO Model Energy Code require that all new homes and heated or air-conditioned additions be designed to maximize thermal resistance and minimize air leakage. Energy trade-off calculations are a method to determine compliance with those provisions.

THE PERMIT APPLICATION CENTER OFFICE OF BUILDING CODE SERVICES

Hours of Operation for Walk-in Customers:
Monday through Friday (except holidays)
8:00 a.m. to 4:00 p.m.

Other publications and forms are
available on the DPWES website:

www.co.fairfax.va.us/dpwes



Herrity Building
12055 Government Center Parkway
Fairfax, Virginia 22035
Telephone: 703-222-0801
TTY: 703-324-1877

Telephone Hours: 8:00 a.m. to 4:30 p.m.

WHAT ARE THE PROCEDURES FOR THE TRADE-OFF WORKSHEET

1. Detach the worksheet from this package. Complete the information in the lines provided at the top and bottom of the worksheet. *House Type* and *Option(s) Included* apply to masterfile drawings only. If separate analyses are provided for masterfile house types with specific option(s), then the option(s) must be clearly noted in the line provided.
2. The following instructions are for the **Walls, Windows and Doors** portion of the worksheet: (Tables 1 B 6 can be found on pages 6 and 7 of this package):
 - a. On the **PROPOSED** side of the form, in the column entitled **Insulation R-Value**, fill in the R-value of the insulation used in the wall cavity of each different wall type in the building (rows for a wall type 1 and a wall type 2 are provided, use blank rows for any additional wall types).
 - b. On the **PROPOSED** side of the form, in the column entitled **U-Value** (the measurement of how well a material or a series of materials conducts heat), fill in the U-value for the most appropriate element description chosen from Table 1 for walls, Table 2 for windows and glass doors and Table 3 for doors. U-values manually calculated for walls and U-values obtained from the window or door manufacturer may be substituted for the values found in these tables. **Center of glass U-values are not acceptable.** Please note: some windows and doors are denoted in R-values. In these cases R-values must be converted into U-values using the following formula: $U\text{-value} = 1 / R\text{-value}$.
 - c. Compute the net area for each wall (total wall area minus the area of windows, doors, etc.) and the total area for each window and door type. On the appropriate rows, input those values in the column entitled **Area** on the **PROPOSED** side of the form.
 - d. On the **PROPOSED** side of the form, for each row, multiply the values in the **U-Value** column with the values in the **Area** column and place the product in the column entitled **UA**.
 - e. Add all the individual areas in the **Area** column on the **PROPOSED** side of the form and place the sum in the box marked **Walls: Total Area**. As shown by the arrow, place this value in the box marked **Total Area** on the **REQUIRED** side of the form.
 - f. On the **REQUIRED** side of the form, multiply the given **Required U-Value** by the **Total Area** and place the product in the box marked **UA** on the **REQUIRED** side of the form.
3. Repeat the procedure described above for the **Ceilings, Skylights and Floors Over Outside Air** portion of the worksheet. U-values can be chosen from Table 6 for ceilings, Table 2 for skylights and Table 5 for floors over outside air. U-values manually calculated for ceiling or floors and U-values obtained from the skylight manufacturer may be substituted for the values found in these tables. **Center of glass U-values are not acceptable.** Please note: some skylights are denoted in R-values. In these cases R-values must be converted into U-values using the following formula: $U\text{-value} = 1 / R\text{-value}$.
4. The following instructions are for the **Floors and Foundations** portion of the worksheet:
 - a. On the **PROPOSED** side of the form, in the column entitled **Insulation R-Value**, fill in the R-value of the insulation used in the basement wall, floors over unheated spaces (crawl spaces, garages, etc.) and crawl space walls (for heated crawl spaces only).
 - b. On the **PROPOSED** side of the form, in the column entitled **U-Value**, fill in the U-value for the most appropriate element description chosen from Table 4 for basement and crawl space walls and Table 5 for floors over unheated spaces.
 - c. Compute the net area for basement walls and total area for floors over unheated space or crawl space walls and input those values in the columns entitled **Area** on the **PROPOSED** and **REQUIRED** side of the form.

- d. On the **PROPOSED** side of the form, for each row, multiply the values in the **U-Value** column with the values in the **Area** column and place the product in the column entitled **UA**.
- e. On the **REQUIRED** side of the form, multiply the given **Required U-Value** by the **Area** and place the product in the column entitled **UA**.
5. On the **PROPOSED** side of the form add all the values from all the rows on the worksheet in the **UA** column and place the sum in the box marked **Total Proposed UA**. Repeat this for the **UA** column on the **REQUIRED** side of the form and place the sum in the box marked **Total Required UA**.
6. If the **Total Proposed UA** is less than or equal to the **Total Required UA**, then the building is in compliance with the Model Energy Code. If the proposed value exceeds the required value, then you may need to increase the R-value of the insulation in the walls, provide higher efficiency windows or decrease the window area of the building.

Please incorporate the following requirements when completing the analysis (see FIGURES 1 and 2):

- a. Walls which separate a living space from the attic space of an attached garage shall include R-13 insulation minimum.
- b. Skylight shaft walls shall be included in the area of the walls (see FIGURE 2).
- c. Walls at the basement level which are greater than 50% above grade shall be included as a wall type in **Walls, Windows and Doors**.
- e. Ensure the insulation R-values used in the trade off worksheet match those shown on the construction drawings.
- f. Batt insulation stuffed, flattened or compressed during installation will not meet the intended R-value.

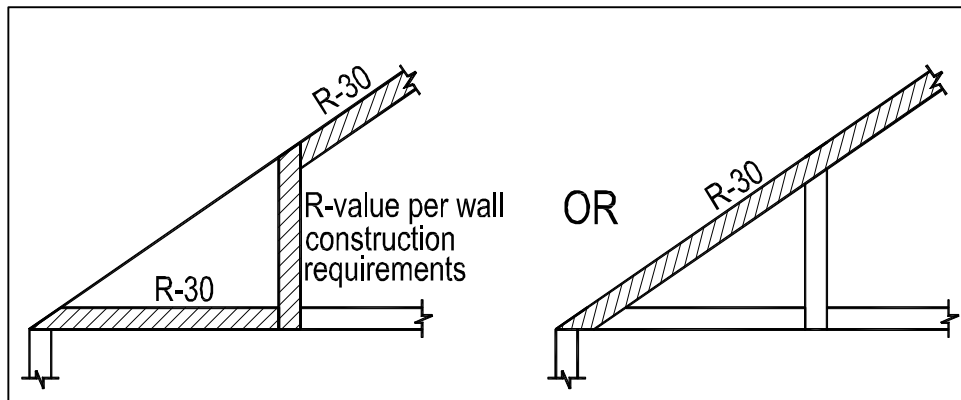


FIGURE 1: INSULATION REQUIREMENTS AT KNEEWALLS

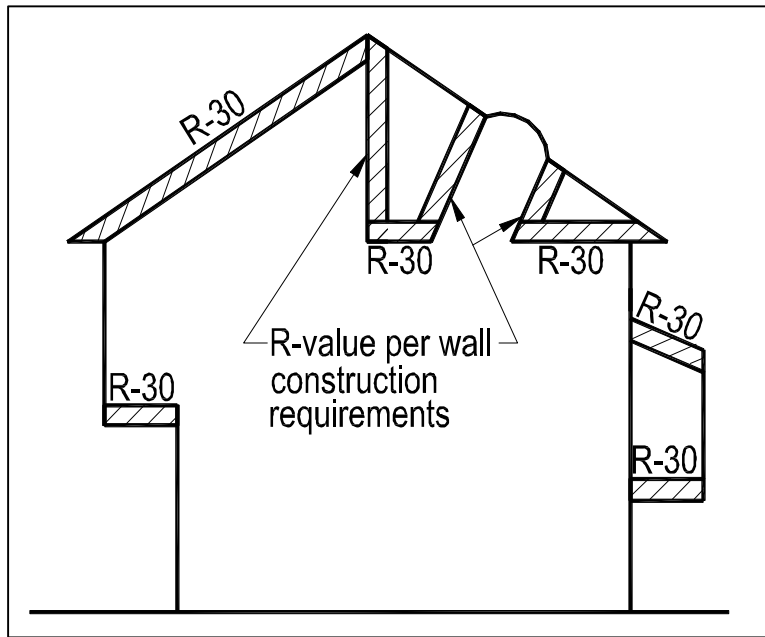


FIGURE 2: MISCELLANEOUS INSULATION REQUIREMENTS

WHAT ARE SLAB-ON-GRADE INSULATION REQUIREMENTS

Slab-on-grade insulation shall start from the top of the concrete slab and shall be continuous for 24 inches as shown in FIGURE 3. Slab edges shall always be insulated. The minimum R-value for an unheated slab is R-4. The minimum R-value for a heated slab is R-6 (heated slabs are those in which heating elements or the hot air distribution systems is in contact with or placed within the slab-on-grade or the subgrade below).

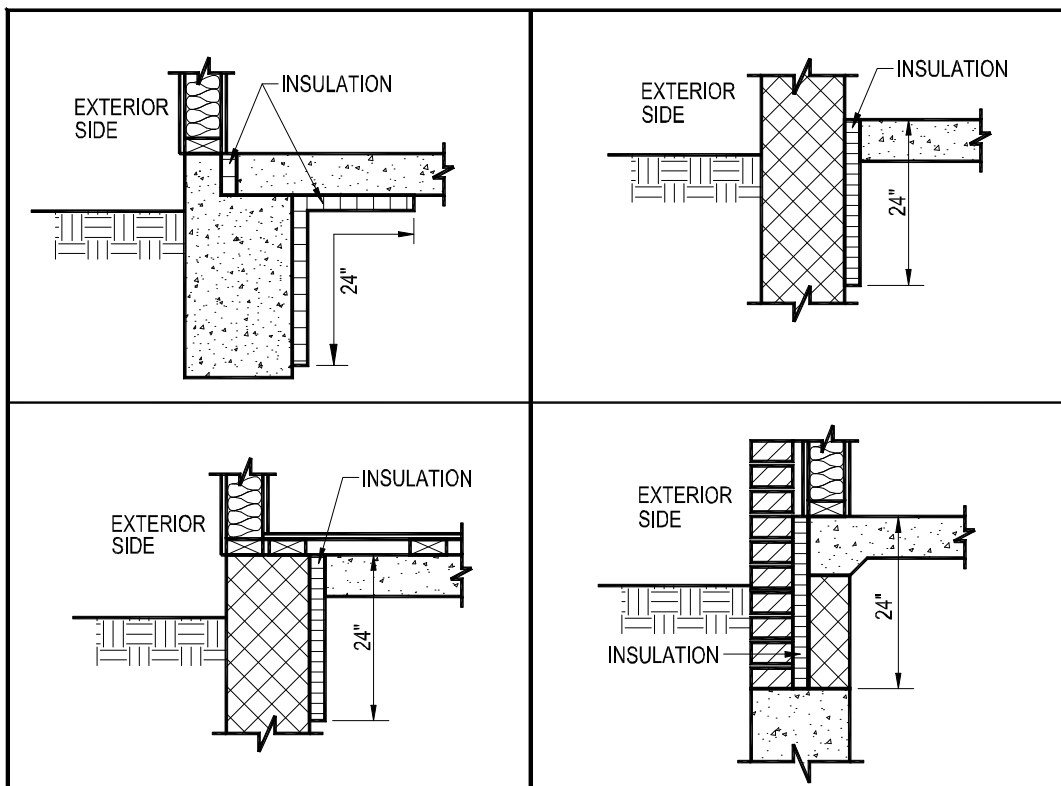


FIGURE 3: SLAB-ON-GRADE INSULATION REQUIREMENTS

WHAT ARE CRAWL SPACE WALL INSULATION REQUIREMENTS

When a crawl space is conditioned and the crawl space walls are insulated and included in the energy trade-off calculations, the wall insulation shall be placed per FIGURE 4.

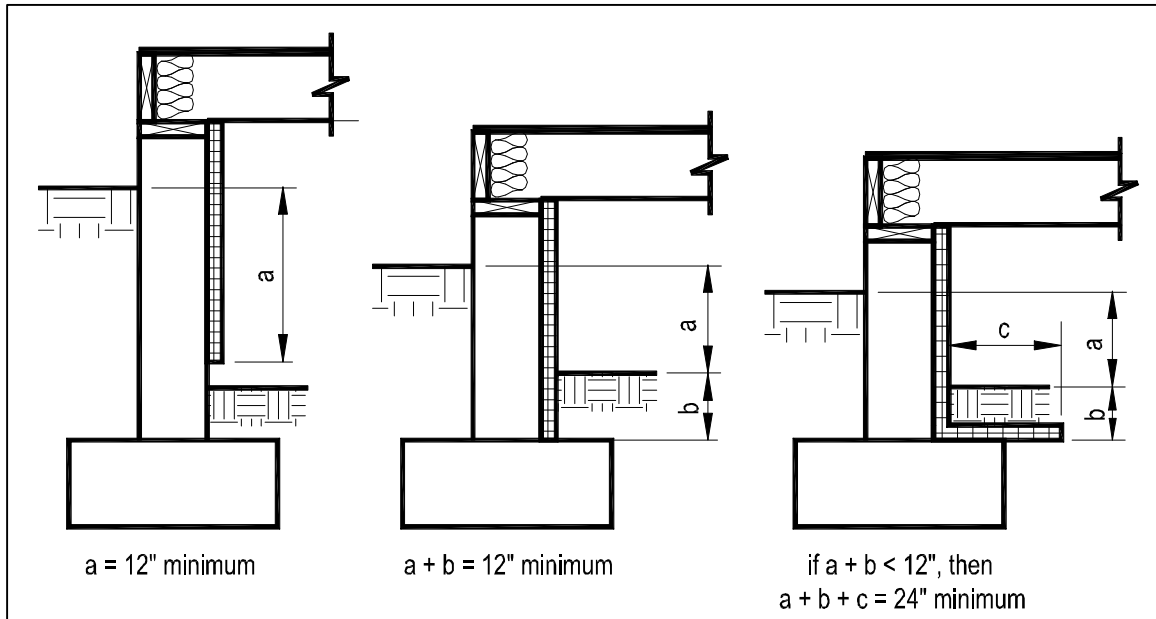


FIGURE 4: CRAWL SPACE WALL INSULATION REQUIREMENTS

WHAT ARE THE SUBMITTAL REQUIREMENTS FOR THE ENERGY TRADE-OFF WORKSHEET

Construction drawings of all new houses and additions which enclose a heated or air-conditioned space are required to have a completed copy of the trade-off worksheet attached to each set. If the worksheet has been signed and sealed by an architect/engineer, then at least one set shall bear an original signature and seal.

Additions which are less than 1000 SF, have no more than one story, and are reviewed under the Walk-Thru Program have an alternate method of analyzing energy envelope compliance. This less complicated method is based on the percentage of windows and doors in the exterior walls up to 32%. See the companion handout entitled *Walk-Thru Energy Worksheets*. All handouts are available at the Permit Application Center, Building Plan Review Division, or, online, at www.co.fairfax.va.us/dpwes.

U-VALUES OF TYPICAL BUILDING ELEMENTS

TABLE 1 - EXTERIOR WALLS

U-Values					
Wall	Sheathing	Cavity Insulation			
		R-11	R-13	R-15	R-19
2x4 or 2x6 studs at 16" or 24" o.c. with an interior finish	2" plywood	0.081	0.071	0.063	0.052
	R-1.5 foam	0.075	0.067	0.060	0.049
	R-2.5 foam	0.070	0.063	0.057	0.047
	R-3.0 foam	0.068	0.061	0.055	0.046
	R-3.6 foam	0.065	0.059	0.053	0.045
	2" plywood + R-1.5 foam	0.072	0.064	0.058	0.048
	2" plywood + R-2.5 foam	0.067	0.060	0.055	0.046
	2" plywood + R-3.0 foam	0.065	0.059	0.053	0.045
	2" plywood + R-3.6 foam	0.063	0.057	0.052	0.044
Plain Concrete with no interior finish ¹	None	0.083	0.073	0.065	0.053
Plain Concrete with interior finish ¹	None	0.080	0.070	0.063	0.052
Concrete block with no interior finish ¹	None	0.077	0.069	0.062	0.051
Concrete block with interior finish ¹	None	0.075	0.066	0.060	0.050

¹ Values are based on above grade conditions; for below grade conditions, see Table 4.

TABLE 2 - WINDOWS, GLASS DOORS AND SKYLIGHTS

U-Values		
Element/type	Single-pane	Double-pane
Metal without thermal break		
Window	1.30	0.87
Glass door	1.26	0.80
Skylight	2.02	1.30
Metal with thermal break		
Window	1.07	0.67
Glass door	1.10	0.66
Skylight	1.93	1.13
Metal-clad wood		
Window	0.98	0.60
Glass door	0.99	0.57
Skylight	1.50	0.88
Wood/vinyl		
Window	0.94	0.56
Window; low E	B	0.48
Window; low E, argon gas	B	0.44
Glass door	0.98	0.56
Skylight	1.47	0.85
Glass block assemblies have a U-value of 0.60		

TABLE 3 - DOORS

U-Values		
Type	without foam core	with foam core
1 ³ / ₄ " thick steel door	0.60	0.35

U-Values		
Type	without storm door	with storm door
1 ³ / ₄ " wood door with 7/ ₁₆ " panels	0.54	0.36
1 ³ / ₄ " wood door with hollow core, flush	0.46	0.32
1 ³ / ₄ " wood door with 1 ¹ / ₈ " panels	0.39	0.28
1 ³ / ₄ " wood door with solid core, flush	0.40	0.26

TABLE 4 - BASEMENT WALLS

U-Values ¹				
	R-11	R-13	R-15	R-19
Plain concrete with no interior finish ¹	0.085	0.074	0.066	0.053
Plain concrete with interior finish ¹	0.081	0.070	0.064	0.052
Concrete block with no interior finish ¹	0.079	0.070	0.062	0.051
Concrete block with interior finish ¹	0.076	0.066	0.060	0.050

¹ Values are based on below grade conditions; for above grade conditions see Table 1.

TABLE 5 - FLOORS

Construction Type	Composite U-Value
2x joists, subfloor, R-19 insulation	0.05
2x joists, subfloor, R-30 insulation	0.03
2x joists, subfloor, R-38 insulation	0.025

TABLE 6 - CEILINGS

Construction Type	Composite U-Value
2x rafters, interior finish, R-30 insulation	0.03
2x rafters, interior finish, R-38 insulation	0.025

WHERE TO GO FOR HELP

Free software offered by the U.S. Department of Energy provides users with a simplified method to compute the same procedures as found in Fairfax County's Energy Trade-off Worksheet. To download the software, go to www.energycodes.org/meccheck/mecdownload.html. Fairfax County currently recognizes the 1995 Model Energy Code (MEC); therefore, download the version entitled "MECcheck for the 1995 MEC."



FOR FURTHER INFORMATION ON THE ENERGY TRADE-OFF WORKSHEET, PLEASE CONTACT THE BUILDING PLAN REVIEW DIVISION AT 703-324-1640.

Source: U.S. Department of Energy/Pacific Northwest National Laboratory.

This document is available in an alternative format upon request. Please contact the ADA representative for the Office of Building Code Services, Room 646, the Herrity Building, 12055 Government Center Parkway, Fairfax, VA 22035-5502. Call 703-324-1828 (voice) or 703-324-1877 (TTY). Allow seven days for preparation of the material.



ENERGY TRADE-OFF WORKSHEET

Job Address: _____

Name of Subdivision: _____ House Type: _____

Option(s) included in Envelope: _____

PROPOSED					REQUIRED		
U-Values can be found in Tables 1 – 6.							
Walls, Windows and Doors							
Description	Insulation R-Value	U-Value	x Area	= UA	Required U-Value	x Total Area	= UA
Wall type 1			ft ²		0.149*	ft ²	
Wall type 2			ft ²		*0.215 for townhomes ↑		
Window type 1	—		ft ²				
Window type 2	—		ft ²				
Window(s) at basement	—		ft ²				
Door type 1	—		ft ²				
Door type 2	—		ft ²				
			ft ²				
			ft ²				
Walls: Total Area			ft ²				
Ceilings, Skylights and Floors Over Outside Air							
Description	Insulation R-Value	U-Value	x Area	= UA	Required U-Value	x Total Area	= UA
Ceilings			ft ²		0.0331	ft ²	
Floors over outside air			ft ²		↑		
Skylight(s)	—		ft ²				
			ft ²				
			ft ²				
			ft ²				
Ceilings: Total Area			ft ²				
Floors and Foundations							
Description	Insulation R-Value	U-Value	x Area	= UA	Required U-Value	x Total Area	= UA
Basement walls*			ft ²		0.1	ft ²	
Floors over unheated spaces			ft ²		0.05	ft ²	
Crawl space walls (heated crawl space)			ft ²		0.075	ft ²	
Total Proposed UA					Total Required UA		

Total Proposed UA must be less than or equal to the Total Required UA

Virginia Architect or
Professional Engineer Seal

Building Designer Name: _____ Occupation: _____

Address: _____ Date: _____

Virginia law requires that where an architect or engineer seal is not present, the plans (including these forms) must be signed by the individual (not company) responsible for the design, including his/her occupation and address.